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APPLICATION NUMBER: ***60/606,905***
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RELATED PCT APPLICATION NUMBER: ***PCT/US05/08474***

THE COUNTRY CODE AND NUMBER OF YOUR PRIORITY APPLICATION, TO BE USED FOR FILING ABROAD UNDER THE PARIS CONVENTION, IS ***US60/606,905***

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PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

Express Mail Label No.

INVENTOR(S)

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Additional inventors are being named on the ______ *separately numbered sheets attached hereto*

TITLE OF THE INVENTION (500 characters max)

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ENCLOSED APPLICATION PARTS ***(check all that apply)***

☑ Specification *Number of Pages* 7 ☐ CD(s), Number ______

☑ Drawing(s) *Number of Sheets* 3 ☐ Other (specify) ______

☐ Application Data Sheet. See 37 CFR 1.76

METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT

☑ Applicant claims small entity status. See 37 CFR 1.27.

☑ A check or money order is enclosed to cover the filing fees.

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The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

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☐ Yes, the name of the U.S. Government agency and the Government contract number are: ______

Respectfully submitted,

SIGNATURE ______ Date September 3, 2004

TYPED or PRINTED NAME Lawrence Harbin REGISTRATION NO. 27,644 *(if appropriate)*

Docket Number: ______

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USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT

PROVISIOAL PATENT APPLICATION

Title: **Axial Flow Propulsion Device Having Reduced Internal Frictional Losses**

Filed: **September 3, 2004**

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Axial Flow Propulsion Device Having Reduced Internal Frictional Losses

Inventors: Donald E. Cornell and William F. Farrell

Cross-Reference To Related Patents or Patent Applications

This invention is related to U.S. Pat. Application Serial No. 10/801,705 entitled High-Speed Axial Flow Marine Propulsion System and Method With Variable Inlet and/or Variable Exhaust Nozzle, filed March 17, 2004 in the name of Donald E. Cornell, which is incorporated herein.

Background

This invention relates to an axial flow pumping device, but more specifically to a housing for such a device particularly suited for marine propulsion.

Present day designs of water jet marine propulsion systems use mixed flow pumping devices where dynamic or impact pressure and centrifugal force contribute to the total pressure at the thrust nozzle. Compared to axial flow designs, mixed-flow designs suffer from limitations in maximum pressures attainable, relatively large size and weight, internal frictional losses, and a greater need to straighten fluid flow at the discharge nozzle. An axial flow device, for example, weighs less, consumes a smaller volume for a given power output, and may be multi-staged to generate higher pressures. Both designs, however, suffer from internal friction resulting from drag or resistance between the fluid and internal components of the pumping device.

It is known that total pressure at the output nozzle of the water jet comprises the sum of hydrostatic (static) and impact (ram) pressure generated by the pumping device. It is also known that the extent of frictional losses increases exponentially with fluid speed. In

each case (mixed or axial flow), an inlet diffuser may be used to vary static pressure before water enters the impeller section. In a multi-stage pumping device, the total pressure between each stage also comprises a combination of static and ram pressure.

Summary

According to the present invention, it was recognized that if a trade-off is made between static and ram pressure by increasing static pressure and reducing ram pressure using a diffuser-type annular chamber between stages of a multi-stage pumping device (with total pressure remaining constant), inherent frictional losses are significantly lowered since friction also exponentially decreases with fluid speed. This results in a more efficient propulsion device.

According, an aspect of the present invention comprises a multi-stage pumping device, such as that described in Serial No. 10/801,705, having diffuser-like chamber between stages to control static and ram pressures according to desired a relationship. Either the construction of the housing or the annular chamber may be varied where the effective area of the chamber in a direction normal to fluid flow is progressively increased or decreased. The height of the stator and rotor blades are correspondingly varied according to the height (clearance between the shaft wheel and housing) within the annular chamber.

Brief Description of the Drawings

Fig. 1 shows a multi-stage axial flow pumping device over with the present invention is an improvement.

Fig. 2 shows an axial flow pumping device where, in the downstream direction, the effective area of the annular chamber decreases in the rotor-stator sections due to increasing drive wheel diameters, and then the effective area of the annular chamber substantially increases prior to reaching the discharge nozzle thereby converting ram

pressure to static pressure (slowing down fluid speed and decreasing internal frictional losses).

Fig. 3 shows an axial flow pumping device where, in the downstream direction, the effective area of the annular chamber decreases in the rotor-stator sections due to decreasing housing diameter but constant drive wheel diameter, and then the effective area of the annual chamber substantially increases prior to reaching the discharge nozzle thereby converting ram pressure to static pressure (slowing down fluid speed and decreasing internal frictional losses).

Description of Invention

Fig. 1 shows a multi-stage axial flow pumping device 10 having an inlet section 12 and a discharge section 14 where a fluid, e.g., water, is forced downstream through an annular chamber 16 from the inlet to the outlet. Chamber 16 including a series of rotor-stator sections 18, 20, and 22 where respective rotor blades 30, 32, and 34 couple drive shaft 36 via respective wheels 38, 39, and 40. Stator vanes 31, 33, and 35 fixedly couple housing 42. It should be noted that annular chamber 16 need not be annular, but such construction is preferred. It is seen that the area or chamber 16 increases at region 17 prior to reaching throat 19 of nozzle 50. This helps convert ram pressure to static pressure.

Fig. 2 shows an axial flow pumping device 20 where, in the downstream direction, the effective area of the annular chamber decreases in the rotor-stator sections 18, 20, and 22 due to increasing diameters of drive wheels 38, 39, and 40. This has the effect of decreasing the effective area of the annular chamber 16 in the downstream direction thereby increasing fluid flow speed. However, upon reaching region 17 of the annular chamber, the effective area abruptly increases thereby substantially increasing the effective area of the annular chamber prior to reaching the throat 18 of discharge nozzle 50. This converts ram pressure to static pressure (slowing down fluid speed and decreasing internal frictional losses) within the propulsor. In the embodiment of Fig. 2, it is also seen that the height of the rotor blades and stator vanes decrease in the

downstream direction. Variable pitch stator or rotor vanes (either or both being variable) may be employed to effect power delivery to the fluid according the desire fluid speed within the respective rotor-stator sections.

Fig. 3 shows an axial flow pumping device 30 where, in the downstream direction, the effective area of the annular chamber 16 also decreases due to a decreasing diameter of housing 42, but the diameters of drive wheels 38, 39, and 40 remain constant. Here, it is seen that the heights of the respective rotors 30, 32, and 34, as well as the height of the respective stators 31, 33, and 35 decrease in the downstream direction. This construction also effects and increase in fluid speed in the rotor-stator sections, but at region 17, the effective area of annular chamber 16 abruptly increases thereby substantially slowing down fluid speed r prior to reaching the throat 19 of discharge nozzle 50. Ram pressure of the high-speed fluid is converted to a high static pressure at lower fluid speed thereby reducing internal friction and providing the desired thrust at nozzle 50. Similarly, variable pitch stator or rotor vanes (either or both being variable) may be employed to effect power delivery to the fluid according the desire fluid speed within the respective rotor-stator sections.

In an alternative design, rather than providing an effective area of annular chamber 16 that progressively decreases in the downstream direction, the effective area of the annular chamber in the downstream direction may increase with transgressing the rotor-stator sections and merger with a region 17 with a less abrupt transition. Thus, the invention embraces various geometrical designs that take advantage of diffuser designs to trade off static and ram pressures to improve efficiencies of a multi-stage axial flow pumping device.

Claims

1. A multi-stage axial flow pumping device having an annular chamber transgressing rotor-stator sections thereof that decrease in the downstream direction and an expansion region prior to a discharge nozzle to convert ram pressure to static pressure.

2. A multi-stage axial flow pumping device having an annular chamber transgressing rotor-stator sections thereof that increase in the downstream direction to convert ram pressure to static pressure prior to reaching a throat of a discharge nozzle.

3. The device of claim 1 where the rotor-stator section have decreasing blade and vane heights, and increasing drive wheels for the rotor blades, in the downstream fluid flow direction.

4. The device of claim 1 where the rotor-stator sections have decreasing blade and vane heights, and the housing diameter decreases in the downstream direction to attain a decreasing effective area of the annular chamber in the downstream direction.

5. The device of claim 1, further including variable pitch stator vanes to attain desire fluid speed across the rotor-stator sections.

6. The device of claim 1, further including variable pitch rotor blades to attain desire fluid speed across the rotor-stator sections.

7. The device of claim 2 where the rotor-stator section have increasing blade and vane heights, and decreasing drive wheels for the rotor blades, in the downstream fluid flow direction.

8. The device of claim 2 where the rotor-stator sections have increasing blade and vane heights, and the housing diameter increases in the downstream direction to attain an increasing effective area of the annular chamber in the downstream direction.

9. The device of claim 2, further including variable pitch stator vanes to attain desire fluid speed across the rotor-stator sections.

10. The device of claim 2, further including variable pitch rotor blades to attain desire fluid speed across the rotor-stator sections.

11. A multi-stage axial flow pumping device having a fluid flow chamber transgressing rotor-stator sections thereof that decrease in the downstream direction and an expansion region prior to a discharge nozzle to convert ram pressure of fluid to static pressure.

ABSTRACT

A multi-stage pumping device having diffuser-like chamber between stages to control static and ram pressures according to desired a relationship. Either the construction of the housing or the annular chamber may be varied where the effective area of the chamber in a direction normal to fluid flow is progressively increased or decreased. The height of the stator and rotor blades are correspondingly varied according to the height (clearance between the shaft wheel and housing) within the annular chamber. The invention provides a trade-off is made between static and ram pressure by increasing static pressure and reducing ram pressure using a diffuser-type annular chamber between stages of a multi-stage pumping device (with total pressure remaining constant), inherent frictional losses are significantly lowered since friction also exponentially decreases with fluid speed. This results in a more efficient propulsion device.

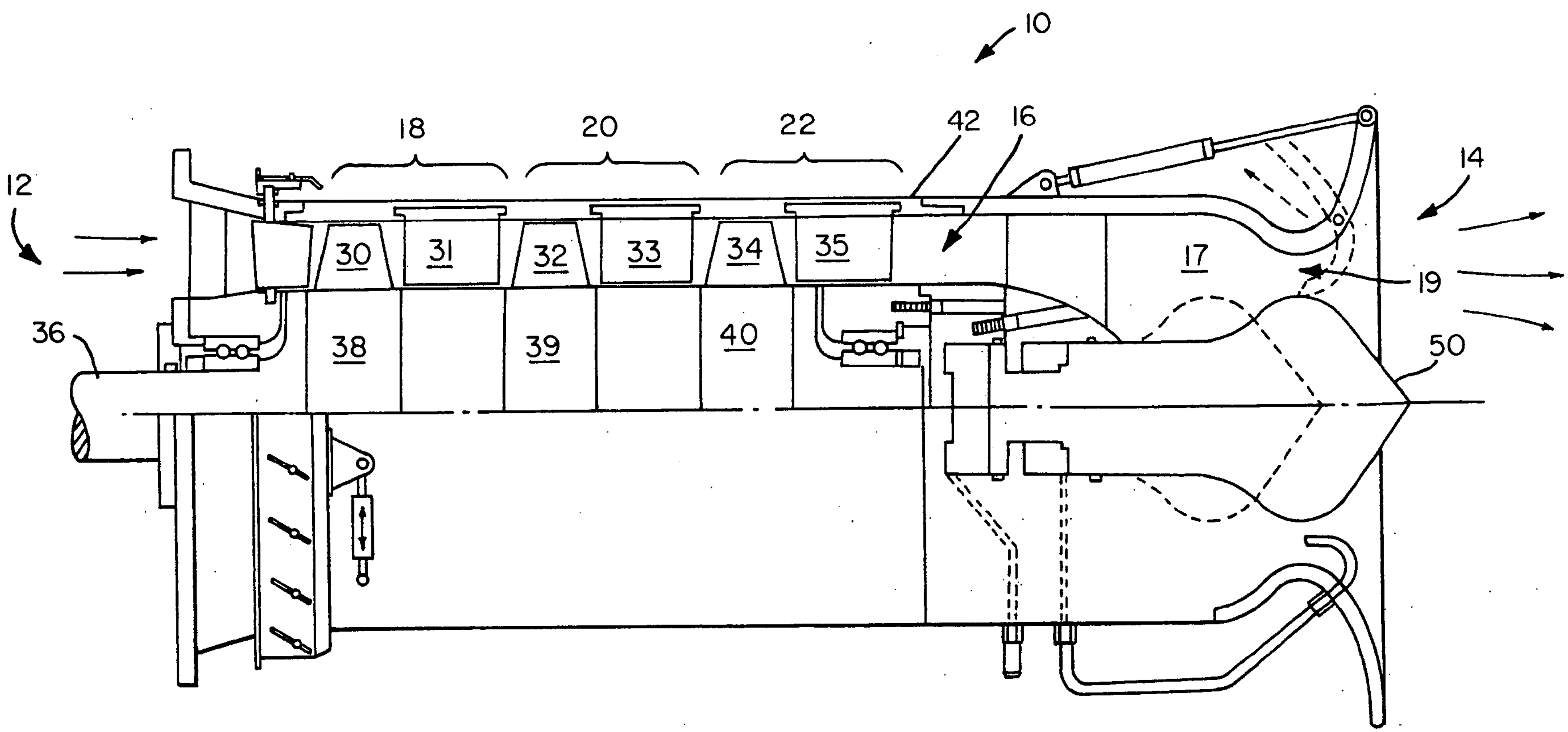

FIG. 1

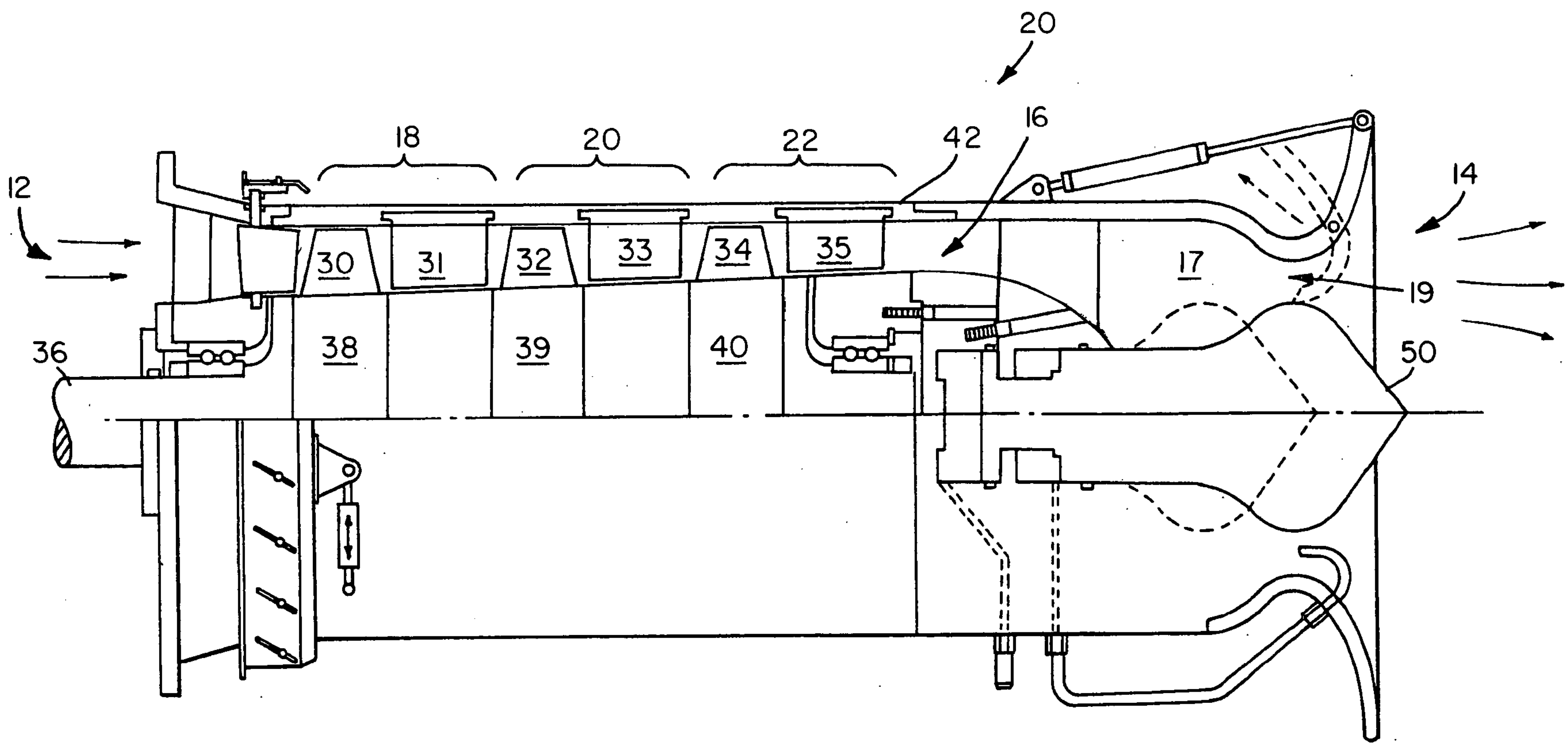

FIG. 2

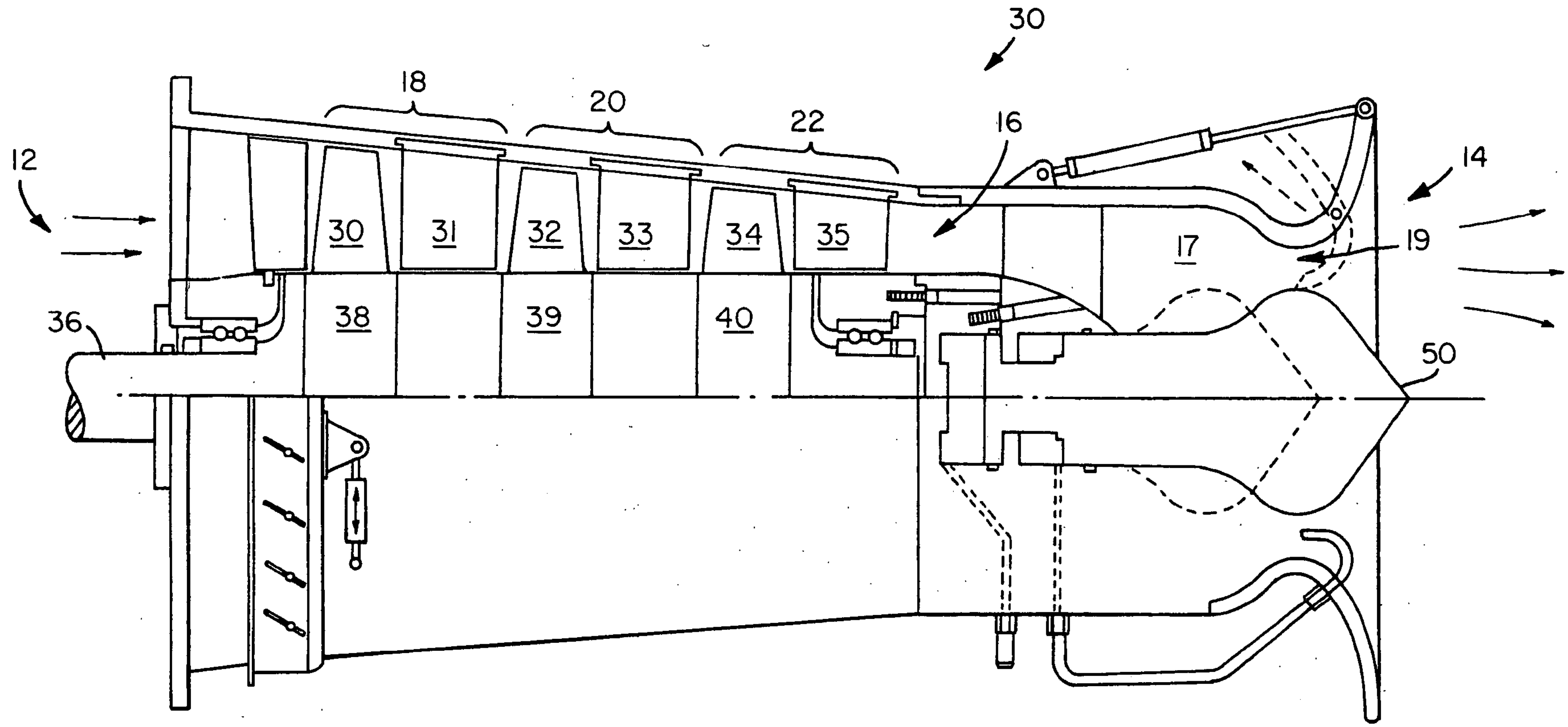

FIG. 3